NETWORK CONNECTION TECHNIQUE IN VoIP NETWORK SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a network connection device connecting different types of networks, and in particular to a data conversion control technique of performing conversion between data on a switched telephone network and packets on an IP (Internet Protocol) network.

2. Description of the Related Art

There has been a data communications network composed of a plurality of switched telephone networks connected by IP networks, which is called a VoIP (Voice over IP) network. In such a VoIP network, a VoIP gateway device is provided between a switched telephone network and an IP network to perform protocol conversion. More specifically, the VoIP gateway device converts an IP packet stream received from the IP network to a data stream to be transmitted to the switched telephone network, and vice versa.

Since a packet stream received from the IP network is composed of control packets and data packets, the VoIP gateway device converts the received data packets to, for example, a voice data stream while processing the control packets. Therefore, if the processor of the VoIP gateway device has a

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low signal-processing capability, then it is difficult to perform conversion from data packets to a voice data stream without a hitch, increasing the possibility of loss of packet and thereby reducing the quality of service such as the quality

5   of reproduced voice. To avoid such a reduction in quality of service, it is necessary to provide the VoIP gateway device with a high-speed processor to increase in throughput.

However, the processing speed of a program-controlled processor is limited. When high-speed processing is needed to

10   process voice and video packets, there is a high possibility that the conversion is not smoothly performed and thereby some packets are discarded.

There have been proposed several Internet telephony techniques in Japanese Patent Application Unexamined

15   Publication Nos. 10-210080, 11-220549, and 11-275070. However, none of these publications teach any technique of increasing in throughput so as not to reduce in quality of service.

SUMMARY OF THE INVENTION

20   An object of the present invention is to provide a network connection device and a data conversion control method allowing high-speed data conversion to ensure sufficiently high throughput.

According to the present invention, a network connection device for connecting an IP (Internet Protocol) network and a switched telephone network, includes: an IP network interface to the IP network; a line interface to the switched

5 telephone network: a plurality of conversion processors, each of which performs conversion between data on the switched telephone network and an IP packet on the IP network; a layer-4 switch connected between the IP network interface and the plurality of conversion processors, for forwarding an IP packet

10 received from the IP network interface to a selected one of the plurality of conversion processors depending on a result of analyzing the IP packet at layer 4; and a multiplexer for multiplexing data received from the plurality of conversion processors to output a data stream to the line interface.

15 The layer-4 switch may determine the selected one of the plurality of conversion processors depending on which one of a control packet and a data packet the IP packet is.

The layer-4 switch may determine the selected one of the plurality of conversion processors based on a source address,

20 a UDP (User Datagram Protocol) header, and a RTP (Real-time Transport Protocol) header of the IP packet.

The plurality of conversion processors may include at least one data conversion processor dedicated to conversion of data packet and at least one control conversion processor

25 dedicated to conversion of control packet. The layer-4 switch may forward an IP packet to a data conversion processor

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when the IP packet is a data packet, and forwards the IP packet to a control conversion processor when the IP packet is a control packet.

5   The multiplexer may demultiplex a data stream received from the line interface to transfer demultiplexed data to a selected one of the plurality of conversion processors depending on whether the demultiplexed data is control data. The plurality of conversion processors may include at least one data conversion processor dedicated to conversion of data packet and 10   at least one control conversion processor dedicated to conversion of control packet. The layer-4 switch may receive packets from the plurality of conversion processors to transfer them to the IP network interface.

According to another aspect of the present invention, a 15   control method for a network connection device connecting an IP (Internet Protocol) network and a switched telephone network, includes the steps of: a) analyzing an IP packet received from the IP network interface at layer 4; b) forwarding the IP packet to a selected one of the plurality of conversion processors 20   depending on a result of the step (a); and c) converting the IP packet to data on the switched telephone network by the selected conversion processor.

The step (a) may be the step of determining the selected one of the plurality of conversion processors depending on which 25   one of a control packet and a data packet the IP packet is.

The step (a) may include the steps of: determining whether

a source address of the IP packet indicates a call agent; when the source address of the IP packet does not indicate the call agent, inspecting a UDP (User Datagram Protocol) header of the IP packet to determine whether a protocol type code of the IP

5   packet indicates UDP; when the protocol type code of the IP packet indicates UDP, inspecting an RTP (Real-time Transport Protocol) header of the IP packet to determine whether a destination port number of the IP packet indicates an RTP port working on call connection; when the destination port number

10   of the IP packet indicates an RTP port working on call connection, determining that the IP packet is forwarded to a conversion processor dedicated to conversion of data packet; and when the source address of the IP packet indicates the call agent, when the protocol type code of the IP packet does not indicate UDP,

15   or when the destination port number of the IP packet does not indicate an RTP port working on call connection, determining that the IP packet is forwarded to a conversion processor dedicated to conversion of control packet.

The control method may further include the steps of:

20   demultiplexing a data stream received from the line interface to produce demultiplexed data; and transferring the demultiplexed data to a selected one of the plurality of conversion processors depending on whether the demultiplexed data is control data.

25   According to still another aspect of the present invention, a network system includes: an IP (Internet Protocol) network;

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a switched telephone network including a service switching point; a SS7 (signaling system No. 7) gateway allowing the service switching point to exchange SS7 signals; a call agent; and a voice over IP (VoIP) gateway for connecting the IP network

5   and the switched telephone network.

The VoIP gateway includes: an IP network interface to the IP network; a line interface to the switched telephone network; a plurality of conversion processors, each of which performs conversion between data on the switched telephone network and

10   an IP packet on the IP network; a layer-4 switch connected between the IP network interface and the plurality of conversion processors, for forwarding an IP packet received from the IP network interface to a selected one of the plurality of conversion processors depending on a result of analyzing the

15   IP packet at layer 4; and a multiplexer for multiplexing data received from the plurality of conversion processors to output a data stream to the line interface.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing the configuration of a voice

20   over IP (VoIP) network;

Fig. 2 is a block diagram showing the configuration of a network connection device according to an embodiment of the

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present invention;

Fig. 3 is a block diagram showing a circuit of a digital
signal processing unit performing conversion between data on
the switch telephone network and packets on the IP network in
5   the embodiment of Fig. 2;

Fig. 4 is a flow chart showing an operation of a layer-4
switch employed in the digital signal processing unit of Fig.
3; and

Fig. 5 is a block diagram showing a detailed circuit of
10   a data converter in the digital signal processing unit of Fig.
3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

NETWORK CONFIGURATION

Referring to Fig. 1, it is assumed that a network 100
15   includes an IP core network 101, a SS7 (signaling system No.
7) gateway (SS7SG) 102, a call agent (CA) 103, a first service
switching point (SSP1) 104, network connection devices (VoIP
GW) 105 and 106, and a second service switching point (SSP2)
107. Here, the IP core network 101 is connected to the first
20   service switching point 104 of a first switched

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telephone network through the network connection device (VoIP
GW) 105 and further to the second service switching point 107
of a second switched telephone network through the network
connection device (VoIP GW) 106. A switched telephone network

5   is typically a public switched telephone network (PSTN).

The SS7 gateway 102 is connected to both the first and
second service switching points 104 and 107 to exchange SS7
signals. The call agent 103 communicates with the network
connection devices 105 and 106 according to media gateway

10 control protocol (MGCP). The first and second service switching
points 104 and 107 communicate with respective ones of
the network connection devices 105 and 106 through bearer
channels.

Each of the network connection devices 105 and 106 is a

15 VoIP gateway according to an embodiment of the present invention.
The network connection device 105 connects the first service
switching points 104 and the IP core network 101 and the network
connection device 106 connects the second service switching
points 107 and the IP core network 101.

20   NETWORK CONNECTION DEVICE

Referring to Fig. 2, a network connection device 1
according to the embodiment of the present invention is provided
with a voice packet processor 2 connected to a line interface
3 and an IP network interface 4. The line interface 3 is

25 connected to a service switching point (104 or 107) of the
switched telephone network. The IP network interface 4 is

connected to the IP core network 101.

The voice packet processor 2 is composed of a plurality
of digital signal processing units, each of which is connected
to the line interface 3 and the IP network interface 4. Here,

5   three digital signal processing units 5-7 are shown for
simplicity but the number of digital signal processing units
is determined depending on the amount of data processing in the
service switching point connected thereto.

When receiving a data stream from the switched

10   telephone network, the line interface 3 transfers it to the
digital signal processing units 5-7. When receiving data
streams from the digital signal processing units 5-7, the line
interface 3 transfers them to the switched telephone network.

When receiving packets from the digital signal processing

15   units 5-7, the IP network interface 4 transfers them to the IP
core network. When receiving a data packet stream from the IP
core network, the IP network interface 4 transfers it to the
digital signal processing units 5-7. The IP network interface
4 performs predetermined protocol processing for transmitted

20   and received packets.

Since the digital signal processing units 5-7 has the same
internal circuit, it will be described taking the digital signal
processing unit 5 as an example.

Referring to Fig. 3, the digital signal processing unit

25   5 is composed of a plurality of conversion processors composed
of data converters (here, three data converters 11-13) and a

processor 14, a multiplexer 15, and a layer-4 switch 16.
The multiplexer 15 is connected to the line interface 3 and is
further connected to the data converters 11-13 and the processor
14. The data converters 11-13 and the processor 14 are connected
5   to the layer-4 switch 16, which is in turn connected to the
IP network interface 4. Each of the data converters 11-13 is
implemented by a digital signal processor (DSP) and the
processor 14 is a central processing unit (CPU).

The multiplexer 15 performs multiplexing and
10 demultiplexing. More specifically, the multiplexer 15
demultiplexes a data stream transferred from the line interface
3 into a plurality of pieces of data, which are classified under
control information and information to be converted by a data
converter. A piece of data to be converted is distributed to
15 a selected one of the data converters 11-13 depending on the
source thereof. Control data is transferred to the processor
14. On the other hand, when receiving voice data from the data
converters 11-13 and control data from the processor 14,
the multiplexer 15 multiplexes these data to produce a data
20 stream, which is output from the multiplexer 15 to the line
interface 3. The line interface 3 transmits the data stream to
the service switching point of the switched telephone network
through the bearer channel.

The data converters 11-13 and the processor 14 perform
25 conversion between data on the switched telephone network and
packets on the IP core network. The data converters 11-13

perform data processing related to voice data, image data, facsimile data, and modem data. The processor 14 performs data processing related to control data.

5   The layer-4 switch 16 performs protocol processing based on layer-4 information in the OSI model. When receiving a packet from the IP network interface 4, the layer-4 switch 16 inspects the packet at layer 4 and analyzes it. Based on the analysis result, the layer-4 switch 16 transfers it to a selected one of the data converters 11-13 and the processor 14. As described

10 above, when the packet relates to voice, image, facsimile, and modem, it is transferred to one of the data converters 11-13. When the packet is a control packet, it is transferred to the processor 14.

The data converters 11-13 and the processor 14 perform

15 data processing determined depending on what the received packet is to produce processed data. The processed data are output to the multiplexer 15, which multiplexes them to output a multiplexed data stream to the line interface 3.

LAYER-4 SWITCH

20 Referring to Fig. 4, when receiving an incoming IP packet (step S1), the layer-4 switch 16 analyzes the incoming IP packet at layer 4 and determines whether the source address of the incoming IP packet indicates the call agent 103 (step S2). When the source of the incoming IP packet is the call agent 103 (YES

25 at step S2), the IP packet is a MGCP (Media Gateway Control Protocol) packet and therefore is transferred to the processor

14 which terminates MGCP (step S5).

When the source of the incoming IP packet is not the call agent 103 (NO at step S2), the layer-4 switch 16 further determines whether its protocol type code is identical to "0x11", which indicates User Datagram Protocol (UDP) (step S3). If the protocol type code does not indicate UDP (NO at step S3), then the IP packet may be TCP (transmission Control Protocol) packet or ICMP (Internet Control Message Protocol) packet and therefore it is transferred to the processor 14 (step S5).

If the protocol type code indicates UDP (YES at step S3), then the layer-4 switch 16 analyzes the TCP segment header thereof to determine whether the destination port number in the TCP segment header indicates a RTP (Realtime Transport Protocol) port currently working on call connection (step S4). When the destination port number indicates the RTP port currently working on call connection (YES at step S4), the layer-4 switch 16 transfers the incoming packet to one of the data converters 11-13 (step S6). When the destination port number does not indicate the RTP port currently working on call connection (NO at step S4), the IP packet may be RTCP (Realtime Transport Control Protocol) packet and therefore it is transferred to the processor 14 (step S5). The packet transferred to one of the data converters 11-13 and the processor 14 is processed depending on data stored in the packet. In this manner, the packet analysis at layer 4 is performed.

The packet processed by the layer-4 switch 16 may be

composed of IP header of 20 bytes or more, UDP header of 8 bytes or more, RTP header of 12 bytes or more, and encoded data of 10 to 160 bytes. The encoded data conforms to ITU-T standards such as G.711, G. 723, and G.729.

5   Since the layer-4 switch 16 is dedicated to packet analysis at layer 4, it is possible to transfer an incoming packet to one of the data converters 11-13 and the processor 14 at higher speeds, compared with the program-controlled processor of the prior art.

10   DATA CONVERTER

Since the data converters 11-13 has the same internal circuit, it will be described taking the data converter 11 as an example.

Referring to Fig. 5, the data converter 11 is connected

15   between an input/output port of the multiplexer 15 and an input/output port of the layer-4 switch 16. The data converter 11 includes a DTMF (Dual-tone Multi-Frequency) detector 21, a frequency-modulation detector (FMD) 22, an echo canceller 23, a facsimile signal demodulator 24, a codec 25 including an

20   encoder 25a and a decoder 25b, an RTP output section 26, a packet jitter processor 27, an RTP input section 28, a facsimile signal modulator 29, a DTMF generator 30, and a selector 31.

The DTMF detector 21 detects a DTMF signal from voice data received from the switched telephone network through the line

25   interface 3 and the multiplexer 15. The frequency-modulation detector 22 detects a modem signal and a G3-facsimile signal

from the voice data and transfers the modem signal directly to
the RTP output section 26 and the G3-facsimile signal to the
facsimile signal demodulator 24. The demodulated facsimile
signal is output from the facsimile signal demodulator 24 to

5   the RTP output section 26. The frequency-modulation detector
22 transfers a voice signal and an image or video signal to the
echo canceller 23.

The echo canceller 23 eliminates an echo from the input
signal and transfers a control signal conforming to, for example,

10   G.711 standard to the RTP output section 26 and further transfers
the signals other than the signal conforming to, for example,
G.711 standard to the encoder 25a. The encoder 25a performs
encoding of an input signal, conforming to, for example, G.723.1
or G.729 and outputs an encoded signal to the RTP output section

15   26. The RTP output section 26 produces packets from input
signals and transfers packets to the layer-4 switch 16.

The packet jitter processor 27 receives an IP packet from
the IP core network 101 through the IP network interface 4 and
the layer-4 switch 16 and corrects a fluctuation in the received

20   IP packet. The jitter-corrected packet is output to the RTP
input section 28. It is not necessary to provide a packet jitter
processor in each of the data converters 11-13. It may be
provided in the output stage of the layer-4 switch 16. In this
case, the digital signal processing unit can reduce in the amount

25   of hardware because the digital signal processing unit
is not needed to be provided with a plurality of packet jitter

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processors.

The RTP input section 28 converts the received IP packet
to a corresponding one of voice data, facsimile data, and control
data. The RTP input section 28 outputs the voice data conforming
5   to G.723.1 or G.729 to the decoder 25b, the facsimile data to
the facsimile signal modulator 29, and the control data
conforming to G.711 to the selector 31. In addition, the RTP
input section 28 outputs a selection signal S corresponding to
the type of data to the selector 31.

10   The decoder 25b performs decoding of voice data conforming
to G.723.1 or G.729 and outputs a decoded voice signal to the
echo canceller 23. The echo canceller 23 generates a replica
to be used for echo cancellation from the decoded voice signal
and transfers the decoded voice signal to the selector 31. The
15   facsimile signal modulator 29 modulates the facsimile data to
produce a facsimile signal and outputs it to the selector 31.

The selector 31 selects one of the decoded voice signal,
the facsimile signal, and the control data conforming to G.711
depending on the selection signal S. A selected signal of the
20   selector 31 is combined with a DTMF signal generated by the DTMF
generator 30 and the signal combined with the DTMF signal is
transferred to the multiplexer 15.

An encoding/decoding system employed in the data converter
is not limited to the above embodiment. Other systems may be
25   employed. In the case of encoding/decoding of image data, for
example, JPEG (Joint Photographic Experts Group) or MPEG (Moving

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Picture Experts Group) may be employed.

    In the embodiment, each of the digital signal processing units 5-7 is composed of a plurality of data converters 11-13 and a single processor 14. Alternatively, it is possible to

5   provide each digital signal processing unit with a plurality of data converters and a plurality of processors.

    As described above, the layer-4 switch is provided to analyze packets at layer 4 and distributes each packet to a selected one of a plurality of conversion processors depending

10   on the analysis result. Therefore, the processing of data packet and the processing of control packet can be performed in parallel by the plurality of conversion processors. In other words, the layer-4 analysis and the processing of control packet are separately performed, resulting in high-speed packet

15   transfer. Therefore, the speed of transferring voice packets to data converters is increased, improving the throughput of the network connection device.